Conceptual Model Elements for Mobile Augmented Reality for Engaging Hearing-Impaired Museum Visitors

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ABSTRACT: Nowadays, designers are more concern with the issue of engagement and informal learning at museum and gallery sites. This has made studies to focus more on the use of Mobile Augmented Reality (MAR) at museum and gallery sites. However, most of the MAR applications for museum visitors are largely tailored to normal hearing visitors while the hearing-impaired (HI) visitors are not supported. Thus, this study explored design elements of mobile augmented reality for engaging hearing-impaired visitors at museum site, develop the conceptual model of MAR for HI museum visitors' engagement based on the identified elements and to evaluate the contribution of the MAR for HI on museum visitors' engagement. The findings of this study that is the proposed the conceptual model for engagement MAR needed for the design of an efficient museum MAR app for hearing impaired visitors' depending on six elements are critical. These six elements include Aesthetics, Usability, Interaction, Motivation, Satisfaction and Enjoyment. This study argues that for an efficient and engaged Mobile Augmented Reality app for the hearing-impaired community most especially hearing-impaired visitors to museum sites. This finding will help Mobile Augmented Reality designers and developers on how to design an efficient and engaged Mobile Augmented Reality app for the hearing-impaired community at large and museum hearing-impaired visitors' specifically.
KEYWORDS**:** Mobile Augmented Reality, Engagement, Museum App, and Hearing-Impaired Visitors.

INTRODUCTION

Augmented reality (AR) involves the introduction of virtual objects into the real environment in order to obtain an augmented environment. This augmented environment is the direct superimposition of physical objects and computer-reproduced objects. The knowledge of AR is influencing human-computer interaction greatly with the today's proliferation of Mobile Augmented Reality applications (MAR apps) and the provision of social support within many domains ranging from healthcare to tourism. MAR apps benefits include mobility, handle, wearability, environment-awareness, multi-modal, flexible usage, visual alerts and reminders which have being social interaction positively. Despite the facts that MAR apps have enormous benefits to human beings both socially and industrially, however, there are still few technical limitations of these applications such as outdoor and portability use, depth perception, tracking and calibration, user experience, overload, and over-reliance (Van Krevelen & Poelman, 2010). Out of these limitations, many studies have focused on users' experience because it is believed to promote MAR social acceptance. This has made researchers such as Lindgren et al. (2016), Ibáñez, Di Serio and Villarán (2014), Di Serio, Ibáñez and Kloos (2013), Dede (2009) and Dow et al. (2007) to investigate on ways to increase users' engagement and learning in MAR. In this study engagement depicts the act of raising users' attractiveness and interest in a pleasing manner in order to get their attention to performing activities at the museums (Di Serio, Ibáñez & Kloos, 2013). Likewise, learning refers to informal learning can be obtain in museum

environment. Nevertheless, there is still lack of study that explores MAR users' engagement and learning criteria among the Hearing-Impaired (HI) people, especially among museum HI visitors and tourists. It is unfortunate that the HI tourists are having huge difficulties not only with accessibility issues within museum but also with engagement experience (Goss, Kollmann, Reich & Iacovelli, 2015). Likewise, it is unfortunate that little is known about how people with hearing losses can have an engaging learning experience within museums. This is because most of the technological solutions and devices provided in the most museums are not suitable and appropriate to enhance HI visitors' and tourists' engagement experience. Hence, this study aims to contribute a conceptual model of engagement with MAR for HI visitors and tourists visiting museums in order for them to have an engaging experience. Nevertheless, there is still lack of study that explores MAR users' engagement and learning criteria among the Hearing-Impaired (HI) people, especially among museum HI visitors and tourists. It is unfortunate that the HI tourists are having huge difficulties not only with accessibility issues within museum but also with engagement experience (Goss, Kollmann, Reich & Iacovelli, 2015). Likewise, it is unfortunate that little is known about how people with hearing losses can have an engaging inform learning experience within museums. This is because most of the technological solutions and devices provided in the most museums are not suitable and appropriate to enhance HI visitors' and tourists' engagement experience. Therefore, this study explored design elements of mobile augmented reality for engaging hearing impaired visitors' at museum site.

METHODOLOGY

The main aim of this study is to explore on engagement MAR elements that are needed for the design of an efficient museum MAR app for hearing impaired visitors'. The study employed the combination of both systematic literature review and expert opinion. This approach was considered suitable based on the objective of the study and as implemented in a similar study by Santos et al (2014). The systematic literature review was used to identify the elements whereas the expert opinion was used to validate (check the consistence of these elements to the real scenario) the identified elements. There were five phases involved in the study methodology as summarized in next steps:

1- Search was conducted on electronic database such as IEEE, Springer, word scientific and SciVerse.
2- (science direct) where MAR engagement element were the key words used.
3- Based on the search, 116 related studies were selected.
4- From the selected studies, 39 elements were identified.
5- Out of the 39 identified elements, only 22 are related to HI
6- 11 elements were selected to sent experts opinion out of the 22 elements presented to validate the model elements.
7- sent 11 elements to 8 experts reviews and the findings 6 elements were relevant to HI in the museum.
8- Built the conceptual model depending on these 6 elements and main components the HI, MAR, museum, and engagement.

Based on the study objectives, the first phase of this study conducted a systematic review from related database on MAR which includes IEEE, springer, world scientific and science direct. The key words used for this review includes mobile augmented reality engagement. These key words were searched combinatorial and interchangeably in order to obtain more specific and refine outcomes. Based on these searches, a total of 116 related studies were selected and reviewed critically where 39 elements were identified. The 39 identified elements were further examined by investigating these that are relevant to HI people where these elements were examined in the light of HI literature. Only 22 out of the 39 elements were found to be related to the HI people. Then, the 22 elements were presented for expert opinion where the experts were made up of academicians HI, museum,

HCI and MAR designer experts and a total of 6 elements were selected. These 6 selected elements are considered as the major engagement MAR elements that are needed for the design of an efficient museum MAR app for hearing impaired visitors'.

The second objective of this study proposed the conceptual model depending on four components the museum, MAR, HI and engagement with the 6 engagements elements from the first objective.

THE ELEMENTS OF MUSEUM MAR FOR ENGAGING HI

Based on Staples and Niazi (2007) suggestions, a critical and comprehensive literature review was carried out by searching multiple bibliographic databases on engagement MAR elements, reference list of previous eligible reviews on engagement MAR elements, contacting scholars within MAR, conference proceedings, key journals and seminar articles related to on engagement MAR, hearing impaired and museum management individually. The outcome of these activities produced a number of elements. However, these elements are further scrutinized which is achieved by checking their usage, definition and suitability. Therefore, the searchlight is focused to only elements that are used in engagement and MAR studies. The result of this produced 11 elements which are presented, then 11 elements sent to expert reviews. the 8 elements after reviews identified in Table 4.1

Table 1: Summary of the Identified Six Elements

Element	Description	Reference
Aesthetics	Visual beauty or the study of natural and pleasing (or aesthetic) computer-based environments	O'Brien and Toms (2010)
Usability	This is the measurement of the suitability and ease of use app functionality as perceived by the users'. It is the users' emotional experienced when using an app and it defines users' efforts, feeling and control on the app.	Othman, Petrie, and Power (2011), O'Brien and Toms (2010)
Interaction	This a form of social relation and connection between users' and an app	Harper and Norman (1993)
Motivation	This is a drive toward involvement in order to achieve (a fun and enjoy) a target (learning or playing)	Gopalan et al (2015)
Satisfaction	This is the act of being contend and fond with an app	Alqahtani and Mohammad (2015)
Enjoyment	The user experiencing fun, joy, satisfaction, peace and fulfilment with the usage of apps.	Pendit, Zaibon, Aida and Bakar (2015), Zaibon, Pendit and Bakar (2015)

CONCLUSIONS

This study has been able to depict vital proposed the conceptual model depending on the elements that are needed for the design of museum MAR apps for engaging HI visitors'. These 6 elements include Aesthetics, Usability, Interaction, Motivation, Satisfaction, Enjoyment This paper argues that for an efficient and engaged MAR app for the HI community most especially HI visitors to museum sites these six elements are critical. It is crucial for museum MAR designers to consider these elements in their designs in order to positively engage the HI community for both inform learning and amusement at the museum sites. Likewise, these elements will ensure that museum MAR app transcend beyond the use of displaying texts and video at museum and gallery sites whereas it will ensure that proper information is communicated and understood for the target users'. Hence, this study has been presented 6 major elements of engagement MAR needed for the design of an efficient museum MAR app for hearing impaired visitors'. Nevertheless, there are still some future work to be done on the issue of

museum MAR apps for engaging HI visitors' such as developing MAR app to guidelines for HI in the museum apps. This will help to evaluate the contribution of the MAR for HI on museum visitors' engagement.

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